

# Modern Concepts of Cardiovascular Disease

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## ELECTROCARDIOGRAPHIC OBSERVATIONS IN CARDIAC SURGERY

The electrocardiograph is an important aid to the surgeon, the medical observer and the anesthetist during an operation performed on the heart. The observer watches the movements of the string shadow constantly and records are taken during vital steps of the operation or when abnormalities in rhythm appear. The heart rate is accurately counted and this is an especial aid to the anesthetist. The electrocardiograph is also helpful in timing the rest periods of the operation on the occurrence of frequent extrasystoles and tachycardias. In one operation a continuous electrocardiogram was taken during the operation, employing the Brush pen recording electrocardiograph.

The patient is connected with the galvanometer in the usual way, the apparatus being located in the corridor or in a room adjacent to the operating theatre. The use of a generous amount of electrode paste insures good conduction throughout the operation. Careful grounding of the operating table in addition to the grounding of the galvanometer avoids the registration of alternating current.

The present observations were made during the operations of Dr. Claude S. Beck at the University Hospitals of Cleveland. There were 63 cases in all, 33 of which were cases of resection of compression pericardial scars for chronic cardiac compression (Pick's Disease). Thirty of the operations were performed in order to produce cardiac anastomoses in cases of coronary sclerosis with angina pectoris. This operation devised by Doctor Beck included rib resection, opening of the pericardium, roughening of the epicardium, implantation of bone dust, and grafting of pectoral muscle to the myocardium.

The patients were given morphine and atropine hypodermically from one to one and one half hours preoperatively. Nitrous oxide-oxygen-ether anesthesia was employed, supplemented by avertin in some instances. Cyclopropane was used in some cases.

Electrocardiographic studies have been made during general surgical operations by a number of observers. They have reported wandering pace-maker, auricular and ventricular extrasystoles, paroxysmal auricular fibrillation, delay in A-V conduction, complete heart block, and ventricular tachycardia. These abnormalities were due to variations in the anesthesia, the degree of anoxemia and visceral trauma. In cardiac surgery there is the important additional factor of manipulation of the heart.

During the operations we have reported that the following electrocardiographic abnormalities were seen in general: ventricular extrasystoles, ventricular tachycardia, deviation of the S-T segment, auricular flutter, A-V nodal rhythm with retrograde conduction, A-V nodal tachycardia, intraventricular

block, transient ventricular fibrillation, wandering pace-maker, changes in the direction of T, auricular extrasystoles, and electrical alternans. Occasional ventricular extrasystoles occurred during the induction of anesthesia and the preliminary steps of the operations (opening of the chest and of the pericardium).

In the 33 operations for resection of compression scars (one patient was operated twice, one was operated three times) there were ventricular extrasystoles in 14 cases (42.4 per cent); ventricular tachycardia of brief duration in 8 cases (24.2 per cent); S-T segment deviations in 5 cases (15.1 per cent); and auricular extrasystoles, wandering pace-maker, A-V nodal rhythm in a few cases. Transient ventricular fibrillation was seen once, the patient recovering. In only a few cases were the T-waves at the end of the operation different from those observed at the beginning of the operation. Electrograms in three cases showed greater voltage after resection of the scar and were typically monophasic. The increase in voltage was probably due to the direct application of the electrode to the myocardium, rather than over the thick and often calcified pericardium. The gradual increase in voltage post-operatively was due to the gradual absorption of the fluid in the tissues, in the pleurae and peritoneum, and increase in the vigor of myocardial contraction.

In the 30 operations for the production of myocardial anastomosis isolated ventricular extrasystoles, ventricular tachycardia (brief in duration) and changes in the position of the S-T segment predominated. Ventricular tachycardias included beats of unifocal and of multifocal origin. Isolated ventricular extrasystoles occurred in 27 cases (90 per cent); there were 14 cases of ventricular tachycardia (46.6 per cent); the S-T segment was deviated in 17 cases (56.6 per cent). Auricular extrasystoles, notching and slurring of QRS, changes in the contour and size of T, electrical alternans, wandering pace-maker, intraventricular block, auricular flutter, A-V nodal rhythm and A-V nodal tachycardia were seen occasionally. These changes were observed most frequently during the manipulation of the heart. Ventricular extrasystoles and tachycardias occurred frequently when the pericardium was being removed and their presence signaled the need for rest periods. It is interesting to note that in spite of the possibility of ventricular fibrillation being initiated by ventricular extrasystoles early in diastole, ventricular fibrillation was never observed in this group of cases.

**Effect of Preoperative Medication.** The frequent occurrence of ventricular extrasystoles and ventricular tachycardia during operations on the heart prompted an experimental investigation of a method to prevent their occurrence by the use of quinidine sulphate (Mautz). Quinidine sulphate was given the

night before the operation (0.2 gm.) and 0.3 gm. was given twice on the morning of the operation. In neither type of operation did this amount of quinidine prevent the disturbances of rhythm but the frequency of their occurrence was decreased.

**Effect of Local Anesthetics Applied to the Cardiac Surface to Reduce Cardiac Irritability:** Mautz showed experimentally that the surface irritability of the heart could be reduced by local application of metacaine and procaine, the maximum effect occurring within five minutes. On the basis of these experimental results, procaine was used by Doctor Beck in human cases. Two cc. of a 5 per cent solution were diffused upon the surface of the heart before the roughening of the epicardium or the dissection of scar, or injected into the right ventricular cavity. This procedure was employed in 12 cases. Striking S-T elevation was frequently seen following the application of the anesthetic as seen in the experiments of Mautz. In some cases the application appeared to reduce the incidence of extrasystoles. No conclusive benefit was observed.

**Heart Rate:** A comparison of the heart rate as obtained from the electrocardiogram (or counting the movements of string shadow) with that as reported by the anesthetist showed wide variations. In many cases the electrocardiographic count was higher due to the fact that weak contractions were not transmitted to the peripheral pulse. The heart rate during the pericardial resection cases varied from 79 to 295 per minute with an average rate of 122. The rate during the cardiac anastomosis operations varied from 50 to 145 with an average rate of 100.

#### Postoperative Electrocardiographic Findings

Changes in the S-T segment occurred frequently, especially in the cases subjected to cardiac anastomosis. In some cases the S-T segment resembled the Pardee Type and T was sharply negative in Leads I and II as seen in Tuberculous Pericarditis. The voltage of the curves, usually low initially, rarely increased immediately postoperatively although the voltage did increase over a period of months in many cases. These deviations resembled the changes seen in acute pericarditis (the deviations were usually upward and were unidirectional). These changes are due to inflammatory reaction of superficial myocardium rather than to cardiac compression (an opening was made into the left mediastinal pleura). Ventricular extrasystoles, A-V nodal rhythm, auricular extrasystoles, auricular fibrillation, auricular flutter and intraventricular block were occasionally seen. In the cases of auricular fibrillation complicating chronic cardiac compression no postoperative return to normal rhythm developed. After recovery from the pericardiectomy, quinidine sulphate was employed but invariably without success.

Electrocardiographic observations during cardiac operations are helpful in guiding the surgeon in his work. The resistance of the heart to operative manipulation is remarkable. There were no immediate operative deaths in the 63 cases.

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#### Selected Abstract

R. Hückel: Zur Frage der Angina pectoris. Medizinische Klinik, v. 33, pp. 942-43, July 9, 1937. Sammelreferat.

Hochrein and Keller (Arch. Exp. path., v. 159, pp. 300 and 312) showed that an increased functional activity provides the conditions for an increased blood supply and for an effectual permeation of the blood through the coronary system. Rein (Verh. dtsch. Ges. inn. Med., p. 247, 1931) has shown that increased frequency of the heart rate promotes a greater supply of blood in the coronary system than when increase of function occurs as the result of increase of stroke-volume.

Regular function of the cardiac muscle only persists while the oxygen supply is adequate; this supply of oxygen is only maintained so long as the coronary vascular system functions. Büchner (Beit. path. Anat., v. 93, p. 169, 1934 and Koronarinfarkt und Koronarinsuffizienz in vergleichender elektrokardiographischer und morphologischer Untersuchung, Leipzig, 1935) showed that in cases in which death followed the anginal attack in a short time large and small necrotic foci, macro- or microscopic, were to be found in the cardiac muscle. Traces of previous attacks could be found histologically in the form of old or recent scars.

Büchner postulated:

(1) Ischaemia and necrosis of the cardiac muscle are the causes of the anginal syndrome.

(2) The well-known frequent fundamental bases of angina pectoris (coronary sclerosis and

syphilis) hinder prompt accommodation of the coronary vessels to the sudden demands upon the heart. Every such demand, even without spasm, leads to the danger of coronary insufficiency and an anginal attack.

(3) The danger of coronary insufficiency also threatens in the presence of aortic insufficiency as the result of peculiarities of the circulatory dynamics in the presence of this defect. Thus, it is plausible, that in aortic insufficiency there is an inclination to attacks of angina pectoris.

(4) In the presence of large infarcts new attacks can probably be excited by renewed demand upon the region of the infarct in the event of unusual cardiac activity. The infarct-autolysate discharged through pressure results in irritation of the sensory end-apparatus.

Büchner also demonstrated that in the presence of healthy coronary arteries, hypoxemia of the cardiac muscle can lead to appreciable morphological changes in the same arteries, especially when the cardiac muscle is greatly under strain, and also markedly deprived of oxygen. Focal changes of this type were found in cats made anemic and then subjected to excessive exercise.

Christ (Beit. path. Anat., v. 94, p. 111, 1934) showed that with a light CO intoxication in rabbits, small disseminated necroses occur in the heart, which, after slight effort, increase in number and extent. These necroses are proportionate to the effect of other hypoxaemic conditions of the myocardium. There was a preference for the same areas, especially for the papillary muscles of the left ventricle and under the endocardium of the sites of outflow.

